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ABSTRACT

This research presents a preliminary overview of the teaching practices of fourth grade teachers throughout the state of New Jersey. These teachers were all involved in professional development experiences designed to help them revise their approach to the teaching and learning of mathematics. In this aspect of the study, we observed at least twice and then interviewed them about their lesson, their practice, and their professional development experiences. In sum, we conclude that while teachers are adopting new techniques such as using manipulatives or cooperative grouping as part of their instructional practices, they are not changing their basic approach to the teaching and learning of mathematics. (Author)

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AN ANALYSIS OF THE TEACHING PRACTICES OF A GROUP OF FOURTH GRADE TEACHERS

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Abstract: This research presents a preliminary overview of the teaching practices of fourth grade teachers throughout the state of New Jersey. These teachers were all involved in professional development experiences designed to help them revise their approach to the teaching and learning of mathematics. In this aspect of the study, we observed teachers at least twice and then interviewed them about their lesson, their practice, and their professional development experiences. In sum, we conclude that while teachers are adopting new techniques such as using manipulatives or cooperative grouping as part of their instructional practices, they are not changing their basic approach to the teaching and learning of mathematics.

Introduction and Theoretical Framework

Many efforts are underway to reform the teaching and learning of mathematics. Some of these efforts involve "radical change in the mathematics taught in schools, the nature of students' mathematical activity, and teachers' perspectives on mathematics teaching and learning" (Simon & Tzur, 1999, p. 252). The goal of these reforms is to move toward instructional practices that provide students with the opportunity to build concepts and ideas as they are engaged in meaningful mathematical activities (NCTM, 1989, 2000). Reforming the teaching and learning of mathematics is not easy , and sometimes, as a result of reform initiatives, teachers may pick up one or more strategies that they believe are associated with the reform movement. However, these may not result in more thoughtful teaching and learning for students (Schorr & Lesh, in press). Researchers such as Simon and Tzur note that "on the basis of our research to date, we suggest that teachers often interpret the current mathematics education reform as discouraging telling and showing. Although teachers have been able to appropriate particular teaching strategies from the reform movement (e.g., using small groups, manipulatives, and calculators), the movement has not provided them with clear direction for how to help students develop new mathematical ideas" (p. 258). Similarly, Spillane and Zeuli (1999), found that many of the teachers involved in a study which explored patterns of practice in the context of national and state math-

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ematics reforms, made use of the new strategies that Simon and Tzur refer to, however "the conception of mathematical knowledge that dominated the tasks and discourse in these teachers classrooms ...[did not] suggest to students that knowing and doing mathematics involved anything more than memorizing procedures and using them to compute right answers" (p. 16).

Stigler and Hiebert (1999), explain why this may be the case. They state that that teaching is a cultural activity, and cultural activities "evolve over long periods of time in ways that are consistent with the stable web of beliefs and assumptions that are part of the culture... and rest on a relatively small and tacit set of core beliefs about the nature of the subject, about how students learn, and about the role that a teacher should play in the classroom" (p. 87). They go on to state that "trying to improve teaching by changing individual features usually makes little difference, positive or negative. But it can backfire and leave things worse than before"(p. 99).

The entire study, of which this research is a part (cf. Firestone, Monfils, & Camilli, 2001; & Schorr & Firestone, 2001) was designed to obtain a more accurate picture of the teaching practices, perceptions, and professional development experiences of a group of fourth grade teachers across the state of New Jersey. It was felt that through this research, we could learn more about the current state of mathematics teaching among these teachers, as well as their ideas about their current practices and professional development experiences. In addition, as part of this study, we also obtained information regarding how the state mandated tests were impacting teaching practices. This information could be used for many purposes, one of which is to assist in making informed policy decisions regarding professional development for teachers. By better understanding the teaching practices and perceptions of these teachers three years after a new state mathematics test had been adopted—the first in the state for elementary schools , we can provide information that helps to inform teacher education projects which intend to help teachers move toward approaches which encourage the development of deeper mathematical understanding in students. Further, by seeing how teachers in general practice, we may be able to contribute to a teacher education agenda for the future.

Methods and Procedures

This particular aspect of the study consisted of several components that are briefly described below.

Selection of Teachers:

University statisticians selected fifty-eight 4th grade teachers who came from districts throughout the state. The districts were representative of the socioeconomic and demographic characteristics of the state.

Classroom Observations:

Each teacher was observed for two math lessons. The classroom field researcher kept a running record of the events in the classroom, focusing on the activities of the teacher as well as capturing the activities of students. The field notes recorded all of the problem activities and explorations, the materials used, the questions that were posed, the responses that were given—whether by students or teachers, the overall atmosphere of the classroom environment, and any other aspects of the class that they were able to gather.

Interviews with Teachers:

At the conclusion of each lesson, the teachers were asked to respond to a series of open-ended questions. Space limitations restrict the number of questions that can be shared in this preliminary format, however, a more complete list will appear in the full paper. Following are a sample of the questions:

> What were you trying to accomplish for today's lesson? What concept or ideas were you focusing on?
>
> What worked well during today's lesson, and why do you think that it worked well?
>
> What, if anything, would you change about today's lesson, and why?
>
> Why did you do this, or how did you feel about that (referring to a particular instance where for example, students explained mathematical ideas to each other or to the teacher, or with regard to a particular event or activity).

There was also a series of questions relating to the teachers' professional development experiences. The following represents a subset of the questions in that category:

> What personal or professional learning experiences (in the past five years) stick out in your mind as strongly influencing how you think about mathematics (these experiences could be within your school, the district or outside of the district)? How did your teaching practice change as a result?

Also included were a series of questions about the impact of state testing on teaching practices, the math topics that they were teaching (and if they felt that they were teaching more or less of any topics as a result of the new state standards and assessments,) etc.

Developing a Coding Instrument:

During the observations a running seminar was conducted with the field researchers. During these seminars, we conducted detailed analyses of records of classroom observations, seeking to pinpoint a series of important themes or issues that could be explored through the classroom observation data. As the observations drew to a close

we adapted several pre-existing coding schemes to be used for coding the classroom data. These were based on the works of Stein, Smith, Henningsen, and Silver (2000); Stigler and Hiebert (1997, 1999); Davis, Wagner, and Shafer (1997); and Davis and Shafer (1998). A preliminary coding scheme was tried out on approximately six observations before being agreed upon. A sheet of code definitions was created and a training session was held for the six coders involved in the activity.

Some of the guiding questions for coding the classroom observations and interview data included the following:

What kinds of activities were the teachers presenting to students?

What kinds of materials were they using, and how were these materials being used?

What kinds of questions were the teachers posing, and how were the students responding?

What was the nature of the discourse that was taking place in the context of the classroom?

Did the lesson provide opportunities for students to make conjectures about mathematical ideas?

Did the lesson foster the development of conceptual understanding?

Coding the Observations:

Two individuals independently coded each observation—at least one of the coders was an experienced mathematics education researcher. After independent coding on all 20 dimensions, inter-rater agreement ranged from a high of 100 percent to a low of 70 percent. Where differences occurred, raters sought to reconcile their differences and were successful in all but 2 of the 108 cases of initial rater discrepancy. In those two cases, another mathematics education researcher discussed differences with the raters and helped them to reach agreement.

Data:

The data includes all 116 (58 teachers, two observations and interviews each) of the transcribed observations and related classroom materials, the coded observations, and transcribed interviews.

Results

The particular aspect of the study that we will focus on for this report pertains to some of the changes that are taking place in classrooms. Our research confirms that teachers are revising their instructional practices to include more group work and hands-on experiences for children. For instance, manipulatives were used in about 60% of all observed lessons. Similarly, students worked in groups for at least a por-

tion of the time, in almost 66% of all observed lessons. We also found that in more than half of all observed lessons, teachers made an effort to connect the ideas that they were teaching to the students' real life experiences.

The adoption of specific strategies was not necessarily accompanied by a change in overall approach to teaching mathematics, however. For example, while manipulatives were used in about two thirds of all cases, they were used in a non-algorithmic manner in less than 18% of all observed lessons. This essentially means that the manipulatives were used in ways that did not necessarily foster the development of conceptual understanding. In fact, in almost two thirds of the lessons where manipulatives were used, they were used in a very procedural manner, where the teacher generally told the students exactly what to do with the materials, and the students did it as best they could. Other times, teachers used manipulatives to demonstrate a particular procedure to the class.

As an example, consider one lesson where the teacher attempted to have students solve a problem using concrete materials—chips, while working in a small group setting (see Schorr & Firestone, 2001 for a more complete analysis and description). The teacher, Ms. J, placed students in small teams (groups) of four to work together to solve the following problem which she had posed: There are eighty-four, fourth graders, and because they've done so well, Ms. J. has decided to take two thirds of them out to dinner with her…so I'm trying to find out what is two thirds of eighty four.

Ms. J. distributed the chips to the students, and told them to work on the problem using the chips—and not using paper and pencil. Many students began to separate the chips into 4 different groups, which was not the strategy that Ms. J. appeared to have had wanted. So, after a very short period of time Ms. J called for the attention of all students as she told them how to divide the chips:

> Ms. J: We need three groups, because two thirds means two out of three groups. So if you have a pile of 84, then you need to make three groups.

Ms. J. then demonstrates the procedure for all of the students by placing chips into three piles. She continued by saying the following:

> Ms. J: And you keep passing them out into groups until you've used up the 84. Remember the denominator tells you the number of equal groups you need. Just like if you play cards, and each person gets the same number of cards, right.

After checking to be sure that each group had made three groups of chips she continued:

> Ms. J: OK, we finished step one. If you want to know what two thirds of 84 is, you have to divide 84 by 3. So how many did you end up with in each group?

Girl: 28

Ms. J: So what do we do now? How do you know what type of equal groups to put them in? What tells you?

Boy: By looking at two thirds?

Ms. J: What tells you? The denominator tells you what number of equal groups to divide by. The divisor or the bottom number of the fraction tells you how many equal groups to make. So does that mean that 28 students can go? Can I get a consensus? (About one half of the students raise their hands). Twenty-eight people cannot go. So what do I need to do now? Two thirds of my 84 students can go. So how many students can go? You're not multiplying; you're using your manipulatives. So what am I doing now? Everyone should have the same amount.

In the above excerpt, the teacher directed the students to make three groups of chips "because two thirds means two out of three groups. So if you have a pile of 84, then you need to make three groups". This was done with little further discussion of, for example, why three groups were needed in this particular problem, or why the three in the two thirds is used to determine the number of groups of chips that the children should have. While the teacher said that the denominator tells you what number of equal groups to divide by, there was no discussion of why that is so, or how that maps into the concrete representation. In fact, there was evidence of confusion throughout the entire lesson.

This excerpt also demonstrates another common thread that emerged in many of the lessons—while many teachers had students physically touch concrete manipulatives, there often was little or no opportunity for the students to develop their own solutions to the problem. As a result, students often did not see the relationship between the problem activity and the concrete (or alternative) representations. To further illustrate, we will continue with the classroom discussion described above, where despite the fact that the students had placed the chips into three groups (as instructed), they were still not able to find a solution to the problem. As a result, Ms. J. allowed a student to demonstrate a written algorithm for division on the board. The student divided 84 by 3 thereby obtaining a quotient of 28. Ms. J. then instructed the students to put all of the chips back into one pile again, and redistribute them so that now they would have only three chips in each group (28 groups of 3).

Ms. J: The whole reason I let you put them into groups of three [referring to the first part of the lesson where the chips were distributed into 3 piles of 28] is that I wanted you to see that when you are dividing, you need to look at the dividend, that is the number I have in all, and the divisor tells me how many in each group…What if I have ten party bags and five people

coming to my birthday party? How many bags would each person get? Each person would get two bags. The divisor tells you how many in each group, and the quotient tells you how many groups. I told you two from each group can go. So now tell me, how many can go. Take two from each group on a blank area of you desk. Now tell me how many people can I take out to lunch.

Ms. J: (to a student who was proceeding incorrectly) No, you take two from each group, and that's how many can go out. How many students can go?

In the above, Ms. J was using a different model for the solution than she had in the beginning. In either case, few, if any, students appeared to understand how the different representations connected to each other, the algorithm, or to the problem activity. Further, it is not clear that Ms. J. ever realized that. In her post lesson interview, Ms. J acknowledged that there was some confusion, but felt that the lesson went well: "I think the manipulatives and the hands-on experience worked well, and I think the cooperative groups with them working together and learning from each other worked well." Wanting to learn more, the interviewer specifically asked her about the different ways in which she instructed the students to use the materials. He said: "At first you started out with having to break the 84 into three groups, and you let them try that and see what, and you talked about why you didn't think that that worked and you had them go back and put them into groups with only three." Ms. J replied:

> Because I wanted them to see the vision. And they kept saying to me—because they knew the algorithm because I showed it to them on Friday [the class before], but a lot of them kept telling me to make groups of three. And then I went ahead and did the algorithm to show them that it wasn't making groups of three, but indeed putting three in each group. I could have told them that they were wrong, but would they have understood it if I hadn't gone back and showed them what they did wrong? That's what I was saying in my mind. Like after they went ahead and they said "well you're supposed to divide what, three into 84," and they got 28. But, when they looked on their desk, they didn't see 28, they saw these three piles. They didn't see their 28 groups that they were looking for.

This example highlights the difficulty some teachers had in making meaningful use of manipulatives to help students build ideas. It also illustrates the difficulty many teachers had in listening to, or closely observing, the mathematical thinking of their students.

As mentioned above, for many teachers, the fact that students used concrete objects, or worked with each other in a small group setting, was an indicator that they were incorporating reform practices into their instruction. They did not consider that

the students were not connecting the different representational systems, or that the concrete objects did not even map into the problem situation or symbolic representations that were used. The fact that they had used concrete materials appeared to be what mattered most, not how they were used, or the level of understanding that was elicited.

As further illustration, consider the following interview with a teacher: "I myself attend a lot of workshops...and I learned that the children need to do the things hands on, because they need to see it, they need to feel it, they need to understand it. And basically everything in my classroom, to the best of my ability, I try to do it hands on." This teacher went on to say that she likes to always have "everything [done as] group work". After the classroom observation, she elaborated on her lesson, and how she felt that she had actually used a hands on and group work approach. She noted that she was "trying to focus on long division, and we have been doing division with two digits in the quotient. And today we took it a step further to do three digits in the quotient, and without remainders". She continued by saying, "I think that [the lesson] went well because instead of doing paper and pencil, and instead of being lectured, and instead of just observing, they actually get to do it, and they use the white boards—those white boards and the markers. They actually are more motivated to do division than they would be any other time. And then having them involved and having them come up to the overhead projector and doing it. And then when they're done, if they're confident, they go around and help the other children."

These and the many other comments made by this teacher help to shed light on what she means by, for example, group-work, hands-on learning, and thoughtful problem-solving activities. Notice that this teacher felt that by teaching in this manner, she was indeed teaching for understanding (and effectively using hands-on and group-work teaching strategies).

Conclusions

This research shows how teachers are adopting specific procedures and techniques and integrating them into their existing paradigm of teaching. Moreover, it suggests that in one state, at least, this adaptation of new techniques to old ways of teaching is rather common. In a more extended paper, we suggest that New Jersey's standards and assessment policies are contributing to the adoption of these new techniques without leading to deeper change (Schorr & Firestone, 2001). This surface change in practice appears to be common to a number of states (Wilson & Floden, 2001).

As a result of the full study, we suggest that teachers lack both the pedagogical and content knowledge to make more radical shifts in practice just because state accountability systems are changing. For the standards movement to lead to deeper changes (NCTM 2000), increases in accountability will have to be accompanied by increases in capacity building in both pre-service teacher preparation programs and continuing professional development programs in schools and districts.

Regarding the specific findings reported in this paper, we suggest that although teachers are incorporating practices they identify with reform, without a deeper understanding of the mathematics they are teaching, no matter how well intentioned, they will continue to approach mathematics instruction as the transmission of an external body of knowledge (i.e., facts and procedures) rather than the creation an inquiry-oriented environment in which students explore and build mathematical ideas. If teachers are to change their practice, they must change their understanding of what it means to know and do mathematics (Schorr & Lesh, in press). Moreover, they will need time and support, in the form of extended and meaningful professional development in the area of mathematics and mathematics pedagogical content knowledge.

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